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GIVE YOUR ANTENNA SOME AIR

Radio Netherlands

Give your antenna some air

Why an outdoor antenna?
On the face of it, the question seems justified as to whether an outdoor antenna is really necessary. Antenna connections are not often found these days on smaller portable radio receivers, and this could be an indication that the built-in ferrite and telescopic antennas are sufficient in themselves.
But this doesn't always follow The ferrite antenna, for instance, is not suitable for shortwave reception, and the ability of the telescopic antenna to pick up shortwave radio signals is often inadequate. Reception conditions inside large buildings and/or close to the ground do sometimes allow tolerable shortwave reception but more often the results are disappointing.
The aim of this booklet is to provide some background to the various outdoor antenna types, and so help you decide how you can best improve reception.
It is important to select the right type of antenna. In view of the widely differing local circumstances and possibilities for erecting an antenna, we have selected some of the most popular types, which will be described later on.
First, some general remarks.
The signals arriving at your antenna have often covered many thousands of kilometres. On the way, the waves were reflected by ionized layers high above the surface of the earth, and also by the earth itself. What remains at the end of the journey is only a fraction of the original strength. The signals therefore need proper handling. Losses in the antenna and in the feeder line must be reduced to a minimum.

Situation
The actual location of the antenna will affect the quality of reception, especially in the presence of local interference sources such as overhead power lines, vehicles, electrical appliances or fluorescent tubes. In most cases, it pays to install the antenna as high as possible, preferably about 2 metres above the rooftop. This helps when passing vehicles cause harmful interference, such as in a city.
Also, select a site as far away as possible from interference sources. Avoid running the antenna wire at a small distance parallel to overhead power lines or to large metal objects like gutters. If you have a portable radio at hand, it can be used to help you select the best position for your antenna. Switch it to different shortwave bands while noting the interference levels at different spots along where you propose to rig the antenna. Make use of the properties of the specific antenna types listed in this booklet, if you fear you might have a real site problem.

Height
The higher an antenna is erected, the better it will perform. Similarly, the more free-standing it is, the better it will perform. Try to avoid shielding by trees, buildings etc. An antenna running over a wet roof will only be at a relatively low altitude above this artificial ,,ground'', and its performance will fall short of expectation. So: give your antenna some air!

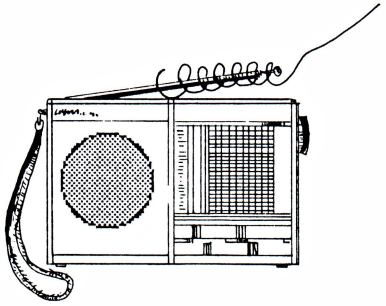
Length
A short antenna is unlikely to ,,catch'' enough signal, but an excessively long antenna will show clear directional properties, so ,,the longer the better'' only holds good up to a certain point. The total length of the outdoor part of the antenna should not exceed 25 metres. Where the space available is larger than needed, an insulator can provide a solution.

Materials
Antenna wire must have a high tensile strength to resist rough weather, as well as offering good electrical conductivity.
For shortwave purposes, copper or copperweld wire nr 18 (about 1 mm diameter) is recommended. The wire can be solid or stranded, bare or insulated. If copper wire is not available, copper-clad steel, aluminium or galvanized steel wire can be used. However, the chosen gauge should be thicker so as to offer reasonable conductivity. Inside, the lead-in can best be made of insulated stranded wire. This is flexible and prevents cracking or damage when touching metal objects in the room.

Insulation
The insulation of the antenna serves to protect the radio frequency (RF) signals from leaking away to the ground. A good RF insulation is therefore a must. Well-known types are glazed porcelain and pyrex-glass insulators. If you have the choice, select a ribbed type because it provides a long leakage path, when its surface tends to become conductive due to dust accumulation, and in wet weather. If you have no choice, you can always put a couple of insulators one after the other to obtain the same effect.
Insulators can also be made of fibreglass, teflon, polypropylene or pvc. A smooth surface limits the accumulation of dust and dirt. If a tree is used as a support for one end of the antenna, use insulators to keep it well away from the foliage.
Stand-off insulators or insulated lead-in bushings can be used for terminating the antenna near or at the point where it is fed through the wall or window frame.
If better materials are not available, use those locally available: TV-stand-off insulators, glass bottles, a ballpoint-sleeve or a piece of plastic conduit for the feed-through insulator.

The lead-in
The interference-level indoors is often higher than outside, so keep the lead-in as short as possible. The use of insulated stranded copper wire is recommended and this should preferably be soldered to the antenna, after twisting the wires together over a length of about 2 to 3 cm. If you are unable to solder, make the connection inside the house to prevent corrosion. (Some electronics shops in Europe and North America sell special sealing substances to prevent moisture reaching the connections).
Clean the wires well with a pen-knife before twisting them together. A (banana) jack or a similar plug can also be used.
Generally, the window frame is used for passing the antenna inside. But this is not recommended if the frames are of metal. In that case, the easiest way is to drill a small hole in the wall at a suitable place as near to the receiver as possible.
Use a piece of plastic tubing to line the hole, extending it about 2 cm at each side, if no suitable lead-in bushing is available.
When you have determined the place where the antenna will be led into the house, try to keep the lead-in away from domestic electrical wiring.

Connecting the antenna to the receiver
To secure a good electrical contact, terminate the lead-in wire with a suitable plug that fits into the antenna input jack of the receiver. In some cases several jacks are available. If so, consult the receiver manual to ascertain which jack serves the AM antenna input. If your receiver has no external antenna connection, it is usually possible to introduce one. A common method is to connect the antenna to the telescopic aerial of the receiver via a small 20 or 30 pF capacitor or trimmer An alligator clip comes in handy for this purpose.
But perhaps the best way is to wrap a few turns of insulated stranded wire (approx. 50 cm in length) at the end of the antenna round the extended telescopic whip (see fig. 1). In this way you make an inductive coupling between the outdoor and telescopic antennas, resulting in increased sensitivity of the latter.



Nowadays, most SW portables are equipped with highly sensitive input circuits. These may become overloaded when extra antenna length is added artificially. However, when the position of the telescopic aerial prevents it from picking up signals effectively, e.g. if the radio is placed in a room well away from the windows, additional antenna length may help considerably.
If the internal antenna is not disconnected when the receiver is tuned to SW, reception may be improved by turning the receiver or putting it in a different position.
If you notice a large number of spurious signals on parts of the dial which are not allocated to broadcasters, try reducing the number of turns round the telescopic whip.

Matching

If the antenna is not properly matched to the antenna input of the receiver, losses are introduced because the signal is reflected at the input jack. To arrive at an optimum signal transfer between the antenna and the receiver, the antenna and feeder line impedances should be approx. equal to the antenna input impedance of the receiver. In most cases, the input impedances of the receiver is not listed, and the optimum signal transfer has to be found by trial and error. However, a certain mismatch is acceptable and receiver input impedance are generally not very critical.
Optimum matching is always desirable with (semi) communications receivers if the manual specifies the antenna input impedance. In the case of domestic receivers, improved matching may be more noticeable for high shortwave frequencies (short wavelengths) than for lower frequencies. Matching can help considerably as you will find out if you were to build a matching unit like the antenna tuner mentioned later on.

Local interference

By far the most interference enters the receiver via the antenna. Generally speaking, interference stems from sparks generated in electrical appliances: vacuum cleaners, sewing machines, hairdryers, coffee-grinders etc.
The heavier electrical appliances like spin-dryers and washing machines are usually equipped with interference-suppressors, and it is practical to fit them as well to smaller electric tools, if these cause interference.
Interference-suppressors are connected to the carbon brush holders of electric machines and are equipped with capacitors to smooth the sparks.
The interference of fluorescent tubes can be suppressed by shielding the auxiliary equipment. If the mains supply has a separate ground wire (the third wire), this must be connected to the fixture shielding.
Another potential generator of interference is the television set. It is equipped with a line-deflection circuit which tends to produce many harmonics, which are in turn picked up and radiated by the TV antenna. As it is not easy to screen a TV-set adequately, it is recommended to keep the shortwave antenna away from the TV-antenna if the TV-set produces spurious radiation.
If you suffer from excessive local interference, screen the antenna lead-in to prevent it from picking up this noise.

Note:
„bandwidth" is not the same as „bandspread" The latter indicates that the short wave range, which runs basically from 11 to 50 metres for international broadcasting, is subdivided into a number of frequency bands on the dial The more bands, the better the bandspread and the easier tuning becomes Bandwidth however, indicates which part of the RF spectrum received is processed in the receiver In old receivers, the bandwidth can be as much as 16 kHz (indicating a maximum audio range of 8 kHz) but in modern receivers it is usually 5-10 kHz The chance of broadcast interference increases with increasing bandwidth, and audio quality is also affected

Broadcast-interference

Mutual interference of shortwave broadcasting stations is caused by the great density of transmitters operating in these bands. Most irritating of all is probably the „heterodyne", a beat note that is generated in the receiver if the carriers of two transmitters are tuned in at the same time. Heterodynes can be suppressed effectively with a so-called „notch filter", but it is not available on most domestic sets.
In order to limit the effect of mutual interference of radio stations, modern receivers are equipped with a rather narrow bandwidth, and some even have a switchable bandwidth in order to adapt the set to varying reception conditions

Screening

It can be useful, or even necessary, to screen part of the antenna from interference sources. Usually, it is the lead-in which passes through interference-fields, so if necessary use coaxial cable for this part of the antenna.
The application of coaxial line has both advantages and disadvantages. The antenna is connected to the inner conductor, while the outer copper braid is connected with a proper ground, so that the lead-in will not pick up interference. The use of coaxial cable allows you to run the wire as you want, without worrying about gutters or domestic wiring, and without the need for stand-off insulators or feed-through bushings.
A disadvantage, however, is that the coaxial lines introduces capacitive losses. To minimize them, it is advisable to use a good low-loss RF type and to restrict the length of coaxial lead-in to a minimum.

Ground

If a screened cable is used for the lead-in, or if you want to increase the efficiency of the antenna, you may want to add a proper ground lead to your receiving gear.
A ground is usually made by driving a bare copper tube into the soil This may be a quick method, but it is not always the best. A good ground is ensured when there is a good contact between the copper and the ground, and this is often better achieved if you bury a strip of copper of about 2 to 4 cms wide and 1.50 to 3 metres long fairly deep in the ground. It helps if you surround the copper with a material that holds moisture, before the hole is refilled. In professional installations, charcoal is frequently used for this purpose. A layer of about 3 cms thick is sufficient. If you keep it wet by putting the whole array under the rainpipe, or if you water it from time to time, you will have an excellent earth. Connect it to the receiver with a thick, bare piece of copper wire.

Lightning protection

Removing the antenna-plug from the receiver is the best lightning protection. Automatic lightning protection by a lightning arrester is not always safe because the unit will become conductive only if the voltage-surge on the antenna exceeds a predetermined value, which can be as high as 70 volts.
Overload protectors are commercially available as they are

frequently used in car radios. Button-sized, quick reacting overload protectors for transistor circuits are available and should be connected as indicated by the manufacturer.
It will be clear that no protection is possible from a near-hit or a direct hit, when strong electrical and magnetic fields accompanying the flash of lightning may damage or destroy your equipment through induction.

Note:
Many micro-processor controlled receivers may „freeze" when static builds up on the antenna input terminals. Removing the batteries, waiting about ten minutes and replacing them again, usually restores the tuning system to normal

Various types of shortwave antennas

Sound as the advice given above may be, it is often difficult to apply it in practice. Fortunately, however, there are quite a number of antenna types from which to choose, depending upon the conditions and requirements encountered. We shall deal with several of these and explain their specific characteristics.

The indoor antenna
This is the least recommended for the simple reason that it is substantially less sensitive than any of the outdoor types. In a wooden house with a non-metal roof, an indoor antenna may give satisfactory results. However, in brick-built houses a short-wave signal is already substantially weakened. In modern apartment buildings in which large quantities of reinforced concrete are used, the metal cage formed by the reinforcing rods virtually eliminates reception.
Many listeners, however, have no alternative to an indoor aerial and thus for their benefit we offer a few hints on rigging.
If you live in an apartment building of reinforced concrete, your antenna should be run parallel to the window since this is the point at which a signal will penetrate the room. A spiralized wire with the ends well insulated and as high as possible, is the best method to tackle the problem of getting the signal in.

The rod antenna
An example of this type is shown in figure 2. It consists of a rod of about 4 to 5 metres, mounted on a high-quality insulator, which in turn is attached to the window-sill. The feeder line to the receiver is kept as short as possible. If a rod is not available, or impractical, it can be replaced by a wire, run alongside a wall.
The top of the antenna should be rounded or, preferably, be fitted with a metal disk or a sphere of about 1 cm or more. The bigger this „end capacity" the better the results.
If the rod antenna can be made free standing, its performance will increase substantially. It is possible to make the rod antenna resonant, to obtain increased sensitivity in one frequency-band only.

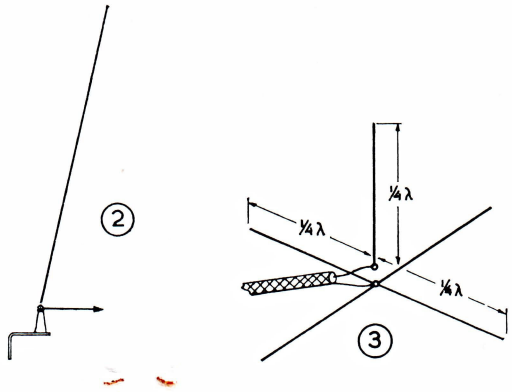


Figure 3 shows the array, which consists of a vertical rod with a length of approx. one quarter of the wavelength to which it is tuned. Directly underneath is the insulator and a system of 4 radials, placed at right angles to each other and mounted horizontally. This forms an artificial ground plane. The radials have the same dimensions as the vertical radiator. A coaxial cable is used to connect the antenna to the receiver as follows: The inner conductor connects the radiator to the antenna jack of the receiver; the screening braid links the radials to the ground terminal of the receiver. This type is known as the ground-plane antenna. It is sensitive to signals from all directions.
To obtain maximum results, the lengths of all the elements should be 3% less than one quarter of the wavelength to which the array is tuned. To find the correct length if you only know the frequency of the station, proceed as follows:
first calculate the wavelength (metres) with the formula:

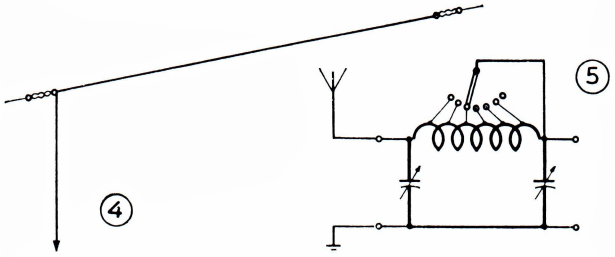
$$\text{wavelength (m)} = \frac{300\,000}{\text{freq. (kHz)}}$$

If you want the antenna for, say, 15 300 kHz, the wavelength comes out at 19.61 metres. One quarter of this is 4.9 metres. The exact length of each element of the antenna is calculated at 3% less than 4.9 metres, giving 4.75 metres (1 metre = 3.28 ft).
The ground-plane antenna can be fed by a 50-ohm cable. Optimum matching between the feeder line and the antenna is obtained when the radials are bent downwards, until they form angles of 120 or 135 degrees with the vertical radiator.
The outer conductor of the coaxial cable is usually not connected to the ground.

The active antenna
This usually consists of a short rod, with at its feed point an electronic circuit consisting of a matching unit and an antenna amplifier. This circuit is fed by a power supply or from a battery. Several commercial active antennas are currently on the market. None are really suitable for use with portable shortwave

radios, since they usually overload the set. If you own a communications receiver, without a built-in antenna, an active antenna can be connected. But don't expect it to give results that are any better than a properly constructed outdoor antenna. An active antenna, mounted on a window ledge, away from TV sets or fluorescent lights, will usually outperform an indoor antenna. Since good active antennas may be quite expensive, ask the radio dealer for a demonstration.
Make sure you have tried all the possibilities for making a passive antenna first. Don't expect a miracle-cure from an active antenna.

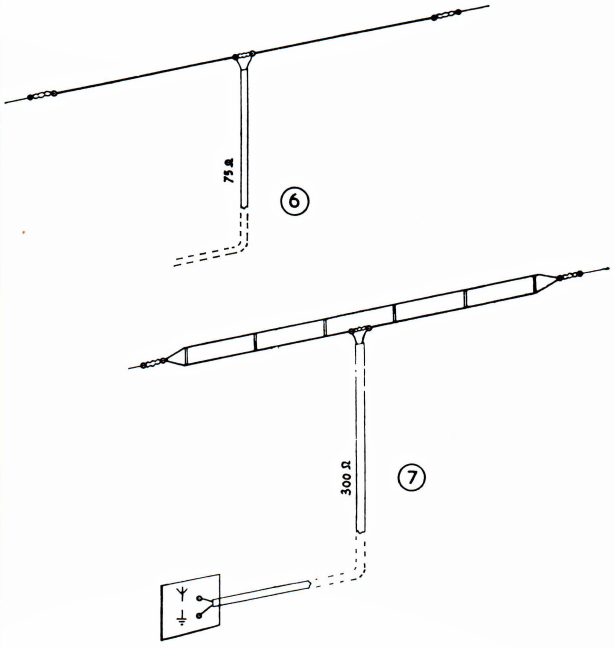
The wire antenna
This type is the most popular general purpose antenna because it is easy to construct, not critical in its dimensions, and gives satisfactory results on shortwave (fig. 4).
The antenna consists basically of a horizontal portion and a downlead, connected to one end of the wire. It is practical to make both antenna and downlead out of one piece of wire. The total wire-length outdoors should be between 9 and 25 metres.
The efficiency of the antenna can be increased if it is combined with a matching unit, the diagram of which is shown in figure 5.



It consists of a coil, made of enamelled copper wire and comprising 15 turns in all, wound on a 2 5 to 3 cm plastic former and tapped at the 12th, 9th, 7th, 5th, 4th and 3rd turn. The taps are connected to a 7-position switch, and from the diagram it can be seen that this enables us to short-circuit part of the coil. Two variable capacitors with maximum capacities of between 360 and 470 pF, complete this unit.
It is connected to the antenna, while its outputs go to the antenna and ground jacks of the receiver. A separate grounding of the unit is optional.
This antenna tuner will enable you to obtain optimum signal transfer from the antenna to the receiver. You will find the best positions for the switch and the variable capacitors by experiment. If the receiver is equipped with an antenna trimmer, however, there is no need for the antenna tuner.
A variation of the wire antenna which seems worthwhile for those who want to experiment, is the Beverage Antenna. It is a non-resonant long-wire antenna which shows a directional effect along the wire axis, for signals entering from the direction

in which it points. You will need plenty of space, away from interference sources.
The longer the horizontal part of the antenna, the better the directivity. For good results, the antenna should be at least 2 wavelengths long. At the far end it is connected to a good ground via a 500 ohm carbon resistor. The receiver should also be grounded, for best results. The Beverage Antenna should be placed at a height of between 3 and 10 metres.
The feeder line to the receiver is a single wire connected as shown in figure 4.

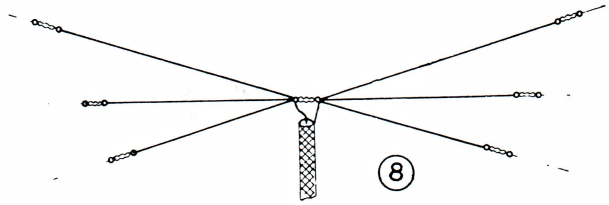
Dipole antennas
The dipole is a resonant antenna with a clear preference for signals arriving broadside to it. Two versions are available: the single dipole, shown in figure 6 and the folded dipole, shown in figure 7.



Both types are 6% shorter than the wavelength for which they are resonant. For the 19 metre band this means a wire length between the terminal insulators of 9.3 metres. Dipole antennas are fed at the centre. The sensitivity of the antenna is approx. twice that of a normal wire antenna. This is valid for sectors of 90 degrees wide centered at right angles to the wire axis of the antenna.
For the single dipole, 75 ohm balanced feeder line is recommended. As this is not available everywhere, two substitutes are recommended: 70 or 75 ohm coaxial wire if the antenna is mainly used for frequencies below 20 mHz, or plastic

insulated lamp cord (consisting of two insulated wires running parallel).
It is connected as shown in figure 6.
For the folded dipole, 240 or 300 ohm balanced feeder line (twin lead, ribbon, tubular line) is used. This line is in common use for television antennas. It should be guided to the receiver via standoff insulators.
The folded dipole consists of two conductors, kept parallel at a distance of about 5 cm (2 inches) by means of spreader insulators. The lower conductor is interrupted in the middle, where the centre insulator is inserted. A folded dipole is relatively easy to put together. Use one wire, which you run from the centre insulator to one terminal insulator, then on to the next terminal insulator, and back to the centre insulator.
It is now easy to adapt the antenna to its desired length after the spreaders are fixed in place. This being done, you can connect the feeder line
If a normal insulator is used in the centre, put the feeder line around it and secure it with insulating tape before you connect it to the ends of the antenna. Thus the weight of the line is not carried by its two conductors alone.
Soldered joints are to be preferred. Use a few dabs of paint or sealing plastic to protect the joints from the weather.
If coaxial cable is used as a feeder line, the centre conductor and the screening are each connected to one terminal of the antenna. The screening braid is removed over a length of about 3 cm by using a nail or a pin to disentangle the individual wires, after which they are twisted by hand into a piece of wire. Now remove the insulation around the centre conductor over a distance of approx. 1 cm and connect both ends as indicated. Don't forget to slug the end of the cable around the centre insulator, securing it to the upcoming cable with insulating tape. This removes any strain on the individual feeder wires.
Coaxial cable is available in various ,,characteristic'' impedances, e.g. 50 ohms, 75 ohms and 125 ohms. Use a cable with a characteristic impedance that matches the radiation resistance of the antenna.

Positioning the dipole antenna
To obtain the correct direction of the antenna with regard to the position of the desired station, you must calculate the direction from which the signals arrive. If this station is more than 3000 km away, you will need a globe and a piece of string Connect the locations of the transmitter and the receiver with the string and read the direction from which the signals arrive. Place the antenna at about right angles to this direction.
As we have pointed out earlier, the direction is not very critical, so that local circumstances can be taken into account. Deviations up to 30° from the optimum direction are certainly tolerable. Dipoles have their lowest sensitivity in the direction of the wire axis. This property can be used if you want to reduce annoying interference from another station. In that case, direct your antenna to the interfering station. The unwanted interference should at least be reduced.
When used on other frequencies the dipole antenna will behave like a good outdoor type, especially on the higher frequencies. You may, however, want to combine a series of dipoles with one common feeder in order to reach the desired directivity on a number of wavelengths. In that case, the multiband dipole, sketched in figure 8, is a possibility. It shows 3 single dipoles, cut for different frequency bands, and all connected to the same centre insulator. The impedance of this array is about 75 ohms. If the antenna serves a domestic receiver of unknown input impedance, 125 ohm coax or twin lamp cord may give better results.



Home-made 300 ohm line
In areas where television or FM-radio have not yet penetrated, it may be difficult to obtain 300 ohm twin line. In that case, you may want to make this line yourself. Select bare or enamelled copper wire and buy a length that is twice the length of the feeder. An excellent 300 ohm line can be made with the help of small plastic spreader insulators, that keep the mutual distance of the wires at six times the diameter. The distance is measured between the centres of the wires.
If this line is strung tightly so that the wires cannot touch in high winds, you have made yourself a feeder that surpasses the quality of the normal polyethylene-insulated types.

And finally.....
This booklet does not pretend to give a full survey of shortwave antennas; only those types that are simple to build and give good results. We hope that you will take time to experiment in order to find the best antenna for your local conditions.
If you want more detailed information on antennas, you can find it in the ,,Shortwave Antenna Course'', which is free of charge on request. Other information that we have available for listeners can be found in our Listeners' Service Catalogue, also free on request.
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